

1

3,516,496

## WELL COMPLETION AND WORKOVER FLUID AND METHOD OF USE THEREOF

James H. Barkman, Jr., Ventura, Calif., and Henry C. H. Darley, Robert M. Jorda, and Robert N. Tuttle, Houston, Tex., assignors to Shell Oil Company, New York, N.Y., a corporation of Delaware  
No Drawing. Filed July 29, 1968, Ser. No. 748,166  
Int. Cl. E21b 33/13

U.S. Cl. 166—281

10 Claims

### ABSTRACT OF THE DISCLOSURE

An improved well completion and workover fluid comprising an aqueous solution containing a synergistic additive mixture of a polyoxyethylene polymer and powdered marble particles of 1-400 micron dimensions and optimally a wetting and bulk reducing agent. The above composition is injected into a permeable subsurface earth formation, e.g., during drilling, well completion or before oil recovery by fluid drive, to temporarily plug desired portions thereof by means of an impermeable filter cake. The filter cake is removed by backflowing and/or dissolving the solid particles with a pH-adjusting fluid which is displaced into contact with the portion of the formation in which the filter cake was formed.

### BACKGROUND OF THE INVENTION

The present invention relates to a new and novel well completion and workover fluid for use in situations in which temporary plugging of a permeable subsurface earth formation is required which on subsequent treatment is readily removed without causing formation damage or swelling of clayey portions of the formation, or decreasing its susceptibility to consolidation treatment, or decreasing the permeability of the treated formation or its susceptibility to a fluid drive for oil recovery.

Proposed completion and workover fluids comprise oil-water emulsions or aqueous systems containing water- or oil-soluble solids which are readily dissoluble in aqueous acidic or oil solvent solutions. Emulsion systems proposed in patents such as U.S. Pats. 2,898,294 or 3,007,865 and aqueous solutions are described in U.S. Pats. 3,000,818; 3,272,741; 3,353,600 or 3,353,604. Generally with systems as described in these patents, it has been found that they are difficult to handle, it requires a long time before their effectiveness is noted in respect to a restoration of permeability making them economically costly to use, they adversely effect the permeability of formations, they tend to plug perforations and portions of the formations and they are difficult to remove without causing damage to the formation and borehole on acid treatment.

### SUMMARY OF THE INVENTION

It has now been discovered that the above undesirable properties of conventional well completion and workover fluids can be obviated and an improved fluid obtained which is capable of temporarily plugging desired portions of a formation and fractures and which is readily removed by a number of suitable means, e.g., backflow or by acidization or subsequent waterflooding or the like which

2

comprise treating a permeable subsurface earth formation so as to temporarily plug desired or selective portions thereof by:

(1) Adding while mixing into an aqueous liquid enough polyoxyethylene to provide a selected type of rheological property and enough solid particles of calcium carbonate or powdered marble of 1 to 400 micron dimensions to provide a selected degree of filter-loss control so as to form a relatively stable single-liquid-phase suspension;

(2) Plugging, with a filter cake formed by the additives suspended in aqueous liquid (1), a portion of the earth formation by pressure control such that the liquid pressure in the suspension exceeds that in the formation; and,

(3) Subsequently restoring the permeability of the earth formation by removing the filter cake formed by step (2) by any suitable means such as, for example, by contacting the portion of formation that was contacted by the suspension with a fluid that adjust the pH of the aqueous liquid around the solid particles to one at which the particles are soluble.

Formations thus treated can be effectively consolidated by use of resinous materials, e.g., epoxy resins as described in U.S. Pats. 3,339,633; 3,368,625 and 3,368,626 and/or subjected to a drive fluid to effectively recover oil from such treated formations. The drive fluids can contain surfactants, thickeners and mixtures thereof.

The present invention specifically differs from prior processes in respect to forming an impermeable filter cake that remains impermeable until it is removed by backflowing and/or a dissolution of the solid particles by the displacement of a pH-adjusting fluid into contact with the portion of the formation on which a filter cake was formed. Also, the steps of depositing the filter cake from an aqueous solution in which the rheological properties are adjusted by a polyoxyethylene and then applying the pH adjustment, provides a combination which is uniquely new, novel and effective in restoring substantially the full natural permeability of the treated portion of the earth formation.

Thus, in fracturing operations, this invention accomplishes the result of U.S. Pat. 3,353,604, on injecting aqueous liquid containing dispersed, slowly dissolving particles of a solid, water-soluble polymer which is subsequently dissolved as more aqueous liquid is injected. The present process differs in the use of bridging particles that become soluble only after a change in the pH of the aqueous liquid.

Also, the present invention accomplishes the results of U.S. Pat. 3,353,600 on injecting a suspension of similarly dissolvable solid particles in an oil-in-water emulsion which breaks after a selected exposure to the earth-formation temperature and provides a partial restoration of permeability that can be augmented by adjusting the pH of the aqueous liquid to one at which the particles are soluble. The present process differs from the patented process in using a single-liquid-phase suspension of solid particles of a bridging size range that yields a filter cake which remains impermeable for as long as desired. The patented process has the disadvantage that if the treatment requiring the temporary plugging of the earth formation is delayed, for example, by an equipment failure, the plug is destroyed before the treatment can be completed.